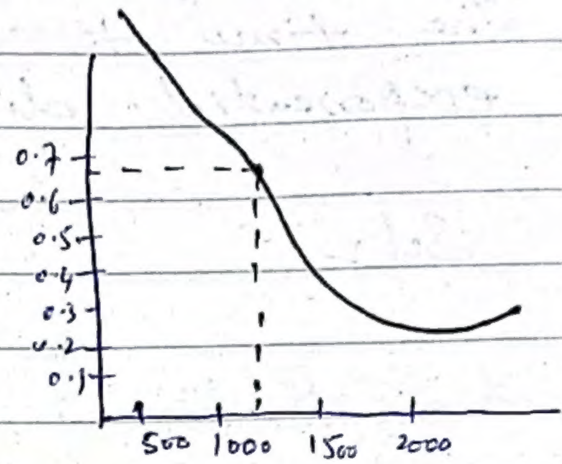
Q No

we have tested 20x unit and found that our MTBF is 2996 Hrs what is the reliability of product @ 1200 hr of operation.

Data:.

$t = 1200$

$\theta = 2996$



we know that

$$MTTF = \theta = \frac{\text{operation Time}}{\text{No. of failure}}$$

$$MTBF = \lambda = \frac{\text{No of Failure}}{\text{operation time}}$$

$$\theta = \frac{1}{\lambda} \Rightarrow \lambda = \frac{1}{\theta}$$

$$\text{Reliability} = R(t) = e^{-\lambda t}$$

$$R(t) = e^{-\left(\frac{t}{\theta}\right)}$$

$$= e^{-\left(\frac{1200}{2996}\right)}$$

$$R(t) = 0.67 \cong 67\%$$

$$\text{Failure rate} = F = 1 - R.$$

$$= 1 - 67\%$$

$F = 33\%$ (unreliable rate

Q No 2
what is the highst Failure rate for a product 26 it is to have a probability of Survival (i-e Successful operation) of 95% at 4000 Hr ? Assume the time to failure following an exponential distribution.

Sol:-

$$R(t) = e^{-\lambda t}$$

$$0.95 = e^{-[4000\lambda]}$$

taking ln on both Side

$$\ln(0.95) = \ln e^{-[4000\lambda]}$$

$$-0.0512 = -4000\lambda \times \ln e$$

$\ln e = 1$

$$-0.0512 = -4000\lambda$$

$$\lambda = \frac{-0.0512}{-4000}$$

$$\lambda = 12.8 \times 10^{-6}$$

48
Imported

Example: 20 units are put on test & run at their normal operating condition for 1000 hrs. If 6 of these units fail at the following hours (550, 480, 680, 790, 860, 620) what is the mean time to failure of the product:

Solution:

"Un Reliability" $F = \dfrac{6}{20} = 0.3 \cong 30\%$

Reliability $(R) = 1 - 0.3 = 0.70 \cong 70\%$

$$MTTF = \theta = \frac{(1000 \times 14) + 550 + 480 + 680 + 790 + 860 + 620}{6}$$

$$\theta = \frac{17980}{6} = 2996 \text{ Hrs to failure}$$

$$\theta = \frac{1}{\lambda} = \lambda = \frac{1}{\theta} = \frac{1}{2996}$$

$$\lambda = 0.00033$$

Weibull distribution:

QNo:

Data:-

$t = 5000$

$\theta = 8000$

$R(t) = ??$

$\beta = 2$

$$\text{Reliability} = R(t) = e^{-\left(\frac{5000}{8000}\right)^2}$$

$$= e^{-0.3906}$$

$$R(5000) = 0.676 \cong 67\%$$

Imported:

Final Exam 2024:

Problem: twenty components with CFR (constant failure rate) was observed being used in a height stressed environment. After 25hr of use seven of them failure at time in hr.

2.1, 8.3, 10.9, 15.2, 16.3, 20.5, 23.8

while the remain still functioning. Calculate the following

(a) MTTF

(2) Failure rate

(3) the time which reliability 95%.

(4) the Reliability of 50 Hrs of use.

(1) $MTTF = \dfrac{(13 \times 25) + 2.1 + 8.3 + 10.9 + 15.2 + 16.3 + 20.5 + 23.8}{7}$

$= \dfrac{422.1}{7} = 60.3$ hrs/failure

(2) failure rate:

$\lambda = \dfrac{1}{\theta} = \dfrac{1}{60.3}$

$= 0.0166$ Failure/hrs.

(B) (3)

· Time at which reliability is 95%

$R(t) = e^{-\lambda t}$

$0.95 = e^{-0.0166 t}$

taking ln on both side

$\ln(0.95) = -[0.0166 \times t] \ln e$

$\ln e = 1$

$-0.0512 = -0.0166 \times t$

$t = \frac{0.0512}{0.0166}$

$\boxed{t = 3.09 \text{ hrs}}$

(4) Reliability after 50 hrs of use

$R(t) = e^{\lambda t}$

$R(50) = e^{-0.0166 \times 50}$

$R(50) = e^{-0.83} = 0.436$

$\boxed{R(50) = 43.6\,\%}$

Q.No:

A Six sided die is tossed

(a) what is the probability of getting a "2"

(b) " " " number that is almost "4"

(c) " " " 3 or 5

(d) " " " No. that is greater then "3"

(e) " " " getting No. that is less then or equal to 5"

Solution:-

$S.S = \{1, 2, 3, 4, 5, 6\}$

(a) Probability getting "2"

$$P(2) = \frac{1}{6} = 0.166 \approx 16.6\%$$

(b) Probability No. that is almost "4"

$S.S = \{1, 2, 3, 4\}$

$$P(x \leq 4) = \frac{4}{6} = \frac{2}{3} = 0.666 \approx 66.66\%$$

(c) Probability 3 or 5

$$P(3 \text{ or } 5) = \frac{2}{6} = \frac{1}{3} = 0.333 \approx 33.3\%$$

(d) Probability of greater then 3
{4, 5, 6}.

$\therefore P(x>3) = \frac{3}{6} = \frac{1}{2} = 0.5 = 50\%$

(e) less then equal 5
S.S = {1, 2, 3, 4, 5, 6}.

$P(x \leq 5) = 5/6 = 0.83 = 83\%$

Q No.

A Jar contains 7 Red marbles 6 green marbles 5 blue marble and 2 yellow marbles:-

(1) what is the Probability of Selecting green marbles.

(2) " " " " " blue Marble

(3) Green or Yellow

(4) Red then blue with replacement

(5) Red then blue without replacement

(6) what is the Probability of Selecting Red then green marble or getting a blue marble and then yellow marble with replacement

Sol:-

Color	marble Qty
Red (R) =	7
Green (G) =	6
Blue (B) =	5
Yellow (Y) =	2
Total =	20

(1) Probability of Green marble

$$P(G) = \frac{6}{20} = \frac{3}{10} = 0.3 \simeq 30\%$$

Not Selecting the green marble.

$= 1 - 0.3 = 0.70 = 70\%$

(2) Probability of Selecting blue marble

$P(B) = \frac{5}{20} = \frac{1}{4} = 0.25 \cong 25\%$

(3) Probability of Selecting Green & Yellow

$P(G) + P(Y)$

$\frac{6}{20} + \frac{2}{20} = \frac{8}{20} = \frac{2}{5} = 0.4 = 40\%$

There ~~are~~ is 40% chance of selecting G or Yellow marbles.

(4) Red then Blue with replacement it means once you take out red marble on 1st try you put it back for 2nd try

$= P(R) \cdot P(B)$

$P(R \text{ then Blue}) = P(R) \cdot P(B)$

$= \frac{7}{20} \times \frac{5}{20} = 0.0875 \cong 8.75\%$

(5) Red then blue without replacement its mean once you take out red marble on 1st try you put separat (other basked) and then try.

$$P(R) \cdot P(b)$$

$$= \frac{7}{20} \cdot \frac{5}{19} = 0.0921 \approx 9.21\%$$

(6) And mean both No. will be multiply

$$P(R) \times P(B)$$

$$\frac{7}{20} \times \frac{5}{19} = 0.0921 \approx \cancel{60} \; 9.20\%$$

Test.

Oct =25 (10)

Example:

what is the highest failure rate for a product of it is to have a probability of survival (ie (Successful operation) of 75% at 4000 Hrs? Assumed that the time to failure following an exponential distribution.

Solution:

Reliability = $R(t) = e^{-\lambda t}$

$95\% = e^{-\lambda(4000)}$

failure rate = $\lambda = \frac{1}{\theta}$

$5\% = \lambda = \frac{\alpha}{4000}$

$\boxed{\theta = 200}$

Log	ln
Log_{10}	Lne

$\ln e = 1$

$\ln \rightarrow$ Natural log.

Solution :

$$R(t) = e^{\lambda t}$$

$$\frac{95}{100} = e^{-[\lambda \times 4000]}$$

$$0.95 = e^{-\lambda \times 4000}$$

$$\lambda = 12.8/10^6 \text{ hrs.}$$

$$\lambda = 0.0000128/\text{hrs.}$$

Thus the highest failure rate is $12.8/10^6$ hours for a reliability of 0.95 @ 4000 hrs.

$$0.95 = e^{-[4000\lambda]}$$

Taking ln on both Side

$$\ln(0.95) = \ln e^{-[4000\lambda]}$$

$$\log a^b = b \log a.$$

$$-0.05129 = -4000\lambda \times \ln e$$

$$+0.05129 = +4000\lambda \times 1$$

$$\frac{0.05129}{4000} = \lambda$$

$$\lambda = 12.8 \times 10^{-6}$$

Imp Pedrul
2021

Example: 20 units are put on test & run at their normal operating condition for 1000 hours 26 6 of those units fail at the following hours (550, 480, 6800, 790 860, 620). what is the mean time to failure of the ~~for~~ Product.

Solution:-

MTTF and MTBF are reflection of the reliability of your product – θ (theta)

$$\text{Failure rate } (\lambda) = \frac{\text{No. of Failure}}{\text{operating Time}}$$

$$\text{MTTF \& MTBF} = \theta = \frac{\text{operating Time}}{\text{No of Failure}}$$

$$\text{un Reliability} = \frac{6}{20} = 0.3$$

the reliability $= 1 - 0.3 = 0.70$

Reliability $= 70\%$

Right data: Censor data left

Minitab:

$= \cancel{1890}$

$$\theta = \frac{(1000\times 14)+550+400+680+790+860+620}{\cancel{20}\ 6}$$

$= \cancel{2998}$

$\cancel{8888}$

$$\frac{17980}{6}$$

$\theta = 2996$ Hrs to failure

Failure rate

$$\theta = \frac{1}{\lambda} = \lambda = \frac{1}{2996}$$

Failure rate $= \lambda = 0.00033$

$$MTTF\ \theta = \frac{1}{\text{Failure rate}}$$

$$= \frac{1}{0.00033} =$$

$\boxed{MTTF = 2996 \text{ Hrs.}}$

Slope = $\frac{\text{raise}}{\text{run}} = \frac{0}{\text{Raise}} =$ $y = mx$.

Slope = $\frac{\text{raise}}{\text{run}} = \frac{\text{Run}}{0} = \infty$

CFD = Constant failure distribution

exponential distribution

Weibull · Distribution

20/8/24.

You have collected on component and calculated that your product fit a weibull distribution.

$$\text{Reliability} = R(t) = e^{-\left(\frac{t}{\theta}\right)^{\beta}}$$

$$5000 = e^{-\left(\frac{5000}{8000}\right)^{2}} = e^{-0.3906}$$

$$R(5000) = 0.6766$$

$$= 67\% \text{ Reliability}$$

$\beta = 2$

$\theta = 8000$

$T = 5000$

CFR = constant failure Rate.
Bath tube curve Explaing.

Final Exam 2024 (7).

Twenty components will CFR (constant failure Rate) was observed being used in a high Stressed environment. After 25 hours of use Seven of them failure at time in hours.

2.1, 8.3, 10.9, 15.2, 16.3, 20.5
23.8

while the remaining is still functioning calculate the following parameters.

1. MTTF
2. the failure rate
3. the time at which the reliability is 95%.
4. the Reliability of 50 hourse of use.

1.

$$MTTF = \frac{(13 \times 25) + 2.1 + 8.3 + 10.9 + 15.2 + 16.3 + 20.5 + 23.8}{7}$$

$$= \frac{(13 \times 25) + 97.1}{7} = \frac{422.1}{7}$$

$$= 60.3$$

② failure rate

$$\theta = \frac{1}{\lambda}$$

$$= \frac{1}{60.3}$$

$$\lambda = 0.0165$$

$$\boxed{\lambda = 1.65}$$

③

$$\text{Reliability} = e^{\lambda t}$$

$$95\% = e^{0.0165 t}$$

taking ln on both sides

$$\ln(0.95) = 0.0165t \ln e$$

$$-0.051 = -0.0165 t$$

$$t = \frac{0.051}{0.016}$$

$$\boxed{t = 3.20}$$

(4)

Reliability = 50 Hrs.

$$R(t) = e^{-\lambda t}$$

$$= e^{0.0165(\cancel{800}\,50)}$$

$$= e^{0.825}$$

$$\boxed{R(t) = 2.28}$$

$R(t) = 0.438$

Problem. (2024) (8)

Imported Problem solve by Teacher

① MTTF

It is the sum of all test time divided by # of failure.

$$MTTF = \frac{2.1 + 8.3 + 10.9 + 15.2 + 18.3 + 20.5 + 23.8 + [13 \times 25]}{7}$$

$$= \frac{422.1}{7} = 60.3 \text{ hours/Failure}$$

(ii) Failure rate

$$\lambda = \frac{1}{\theta} = \frac{1}{60.3}$$

$$\lambda = 0.0166 \ \frac{\text{Failure}}{\text{hrs.}}$$

(iii) time @ which Reliability is 95%

$$R(t) = e^{-\lambda t}$$

$$0.95 = e^{-0.0166t}$$

$$\ln 0.95 = [-0.0166t] \times 1$$

$$\cancel{-}0.0513 = \cancel{-}0.0166t$$

$$t = \frac{0.0513}{0.0166}$$

$$\boxed{t = 3.09 \text{ hours}}$$

(iv) Reliability after 50 hours of use

$$R(50) = e^{-0.0166 \times 50} = e^{(-0.0166 \times 50)}$$

$$R(50) = 43.6\%$$

Probability:

which estimating that probability of a complex system like Aircraft carrier or an oil-Rig it is inpractical to test those system to distribution. So the reliability of these system are calculated by estimating the reliability of individual components

Rule #1

If A & B are two events of interest and P_A & P_B are their respective probabilities of them occuring then If A & B are independent

$$P(A \& B) = P_A \times P_B$$

Rule #2

If A & B are mutually ~~exeutsive~~ excutsive the

or only one will be avaifale at same time

$$P(A \text{ or } B) = P_A + P_B$$

Rule #3

If $A_1, A_2, A_3 \ldots\ldots A_n$ are mutually exclusive event and they discribe all possible outcomes in a particular situation then.

$$P_1 + P_2 + P_3 + \cdots P_n = 1$$

Rule # 4.

If there are only two possible outcomes (say) Success & failure

$$P(\text{success}) = 1 - P(\text{Failure}).$$

Note

$$P(A) = \frac{\# \text{ of favourable outcomes}}{\text{Total possible } \# \text{ of outcome}}$$

So the reliability of event A occuring is $0 \leq P(A) \leq 1$

never.   Always happen

Sample. ~~Spretz~~. Space

A Set of all possible outcomes that Can be occure

Q.No 1

1 coins — Head / Tail.

$S.S = \{H, T\}$.

Q.No 2

what if we flip a two coin what are the possible outcome what would be Sample space

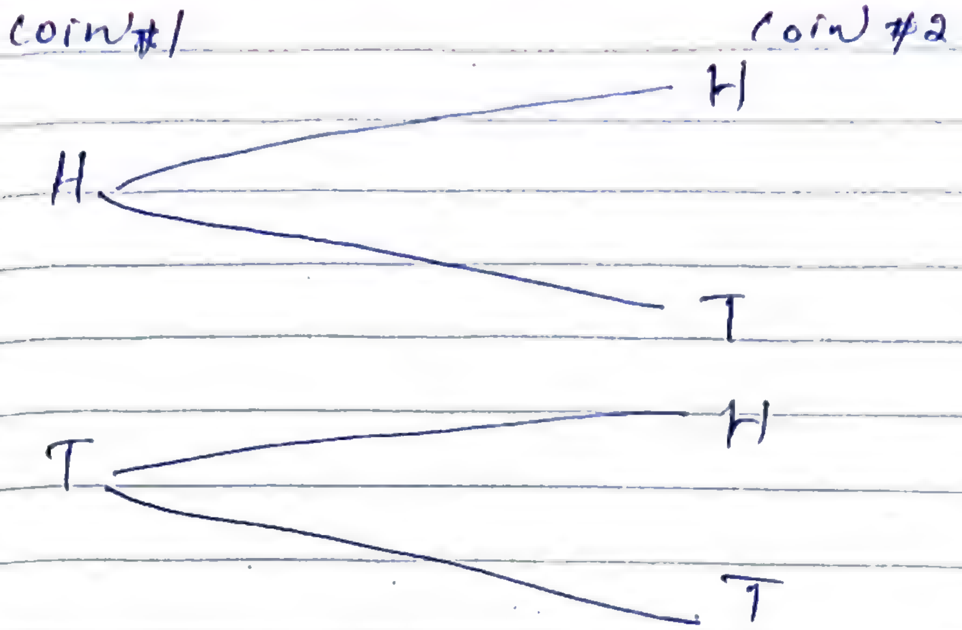
$$= \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}.$$

$S.S = \{H, T, T,H, T,T, H.H\}$.

Tree diagram

Coin 1 — H / ~~H~~T

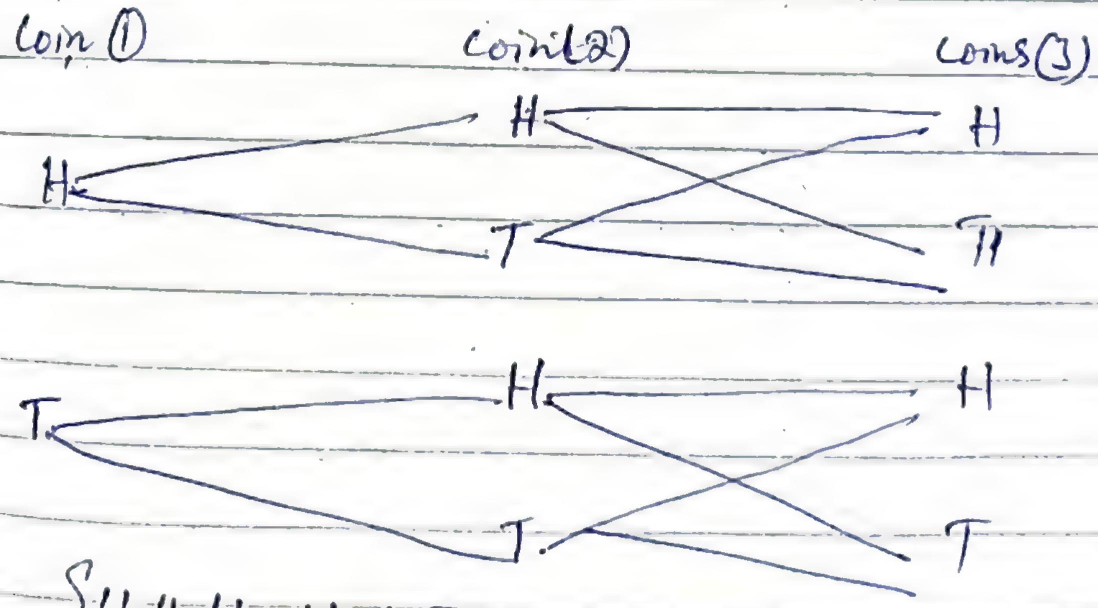
Coin 2 — T / H



$= 2^n =$

Probability

3 coins



{~~HHH, H, H, H, T, HHT, HHT~~, T.

$= 2^3 = 2\times2\times2 = 8$

$\{H,H,H,\ HH,T,\ H,T,H,\ H,T,T,$

$TH,H,\ THT,\ \cancel{H}TTH,\ TTT\}.$

Probability Question

If two fair coin a flip what is probability of getting at least

(a) getting one Head

If three coin flip what probability

Atleast two tail.

(B) three coins are flip. what is. what is the probably exactly one Tail

also construct of ~~the~~ tree diagram

Construct S.S. ~~etc~~

(a) $\frac{7}{8}$ 2

(b) $\frac{3}{8}$

(c) $7/8$.

LC # 26/9/2024

Probability

Q No:

A six sided die is tossed

(a) what is the probability of getting a "2"

(b) what is the probability of 3 or 5

(c) " " " number that is

(d) almost 4

d " " " number that is ~~almost~~ greater then 3.

(e) what is probability of getting number that is less then or equal to 5.

Solution

(a) $P(2) = \frac{1}{6} = 0.166$

(b) Probability of 3

$P(3 \text{ or } 5) = \frac{2}{6} = \frac{1}{3}$

~~Probability of 5~~

~~$P(5) = \frac{1}{6}$~~

$S.S = \{1, 2, 3, 4, 5, 6\}.$

(c) Probability of almost 4.

$\{1, 2, 3, 4\}.$

$P(x \leq 4) = \frac{4}{6} = 2/3 = 0.666$

(d) Probability of ~~almost~~ greater than 3.

$S.S\ \{4, 5, 6\}.$

$P(x > 3) = \frac{3}{6} = \frac{1}{2} = 0.5 =$

(e) less then equal 5 $S.S\ \{1, 2, 3, 4, 5\}.$

$P(x \leq 5) = 5/6 = 0.83.$

2

Q No

A Jar Contains 7 red marbles. 6 green marbles, 5 blue marble and 2 yellow marbles

(1) what is the probability of selecting green marbles.

(2) " " " " " " blue marbles.

(3) Green or yellow

(4) Red then blue with replacement

(e) Red then blue without replacement

(f) Red & blue without replacement

(g) What is the probability of selecting Red then green marble or getting a blue marble and then yellow marble with replacement

Then multiply
are → Sum

with replacement
first Ball replacement again
Placed in same basket

without replacement
Ball pick & place in other
basket & then take new.

(a)

$P(Red) = \frac{7}{20} = 0.35$

(b) $P(blue) = \frac{5}{20} = 0.25$

(c)

(d) $\frac{12}{20} =$

(a)

$S.S = \{7Red, 6G, 5B, 2Y\}$

Total marble $= 20$

$= \frac{7}{20} = 0.35$

(c) $= \frac{8}{20} = 0.4$

$d = 5 \times 7 = 35$

red $\frac{7}{20} = 0.35$

blue $\frac{8}{20} = 0.4$

e. $\frac{7}{20} = 0.35$

(e) $\frac{5}{19} = 0.263$

(f) $\frac{12}{20} = 0.6$

$\frac{12}{19} = 0.63$

$5/20$ $\frac{7}{20}$,

$\frac{2}{20}$, $6/20$

Or =

Solve by teacher.

Color	marble Q-ty.
Red (R)	7
Green (G)	6
Blue (B)	5
Yellow (Y)	2
Total	20

(a) $P(G) = \frac{6}{20} = \frac{3}{10} = 0.30 = 30\%$

Not selecting the green marble

$= 1 - 0.3 = 0.7 = 70\%$

(b)

$P(B) = \frac{5}{20} = \frac{1}{4} = 0.25 = 25\%$

(c) OR = Adding both Probability

$P(G) + P(Y).$

$\frac{6}{20} + \frac{2}{20} = \frac{8}{20} = \frac{2}{5} = 0.4 = 40\%$

There is a 40% chance of selecting a B or Y marbles.

FIRE → Extinguish.

Find, Inform, Restrict

(d) Red then blue with replacement it means once you take out red marble on 1st try you put it back for 2nd tray.

$P(R) \cdot P(B)$.

$$\frac{7}{20} \cdot \frac{5}{20} = 0.0875 = 8.75\%$$

(e) Red then blue without replacement it mean once you take out red marble on 1st try you put seperate (other basket) and then try.

$P(R) \cdot P(b)$

$$= \frac{7}{20} \cdot \frac{5}{19} = 0.0921 = 9.21\%$$

(f) And mean both no: will be ~~addition~~ multiply

$P(R) \times P(B)$

$$= \frac{7}{20} \times \frac{5}{19} = 0.6 = 60\%$$

0.0921

$= 0.35 \times 0.263 =$

$= 9.20\%$

(f) order not specified

Red and Blue without Replacement

[R][B] OR [B][R]

$\left[\frac{7}{20}\right]\left[\frac{5}{19}\right] + \left[\frac{5}{20}\right]\left[\frac{7}{19}\right]$

$(0.35)(0.2632) + (0.25)(0.3684)$

$0.0921 + 0.0921$

$= 0.1842 = 18.42\%$

(g)

[R][G] or [B][Y]

$\left[\frac{7}{20}\right]\left[\frac{6}{20}\right] + \left[\frac{5}{20}\right]\left[\frac{2}{20}\right]$

$(0.35)(0.30) + (0.25)(0.1)$

$0.105 + 0.025 = 0.13 = 13\%$

$= 13\%$

Mutualy exclusive: never come exclusive Simultaneously.

Q No:

Note:

* Dice and coin throwing are always independent event

* they don't have any past memory.
* they are unbiased. and are all equally probable & can occur randomly.

Adding Rule:

$$P(A \text{ or } B) = P(A \cup B).$$

occuring together

$$= P(A) + P(B) - P(A)P(B) \ \{P_A \cap P_B\}$$

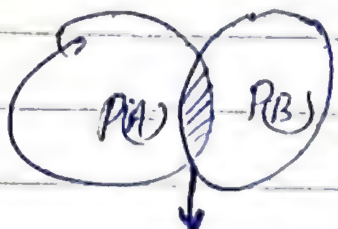
* two events which are mutully Exclusive.
(they cannot occur Simultaneously)

$$P(A \& B) = 0$$

* If A & B are different Events.

$$P(A \cup B) = P(A) + P(B) - P(A \cap B).$$

through Venn diagram.



$P(A \cap B)$.

Multiplication Rule:

- Conditional Probability (event are not independent.

$$P(A/B) = \frac{P(A \& B)}{P(B)}$$

Probability of A given (B)

Multiply Both side by P(B).

$$P(A/B) \times P(B) = \frac{P(A \& B)}{P(B)} \times P(B)$$

$$P(A \& B) = P(B) \times P(A/B)$$

$$P(B/A) = \frac{P(A \& B)}{P(A)}$$

Multiple by both side by P(A).

$$P(A \& B) = P(B/A) \times P(A)$$

Independent Event (IB).

An I.E is that if one event does not depend on another event.

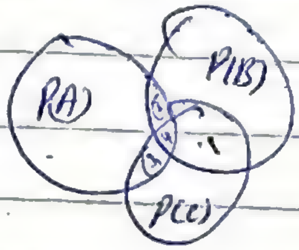
For I.E

$$P(A/B) = P(A).$$

$$P(B/A) = P(B).$$

Additional Rules.

Apply add Rule to 3 or more Probability



$$P(A \cup B \cup C) = P(A) + P(B) + P(C) + P(A \cap B)$$

$$+ P(A \cap C) + P(B \cap C) - P(A \cap B \cap C)$$

L.C.#   4/10/2024

Q No

what is the probability of rolling a 4 or 3 when a six side choice is tossed up.

Sol

$P(A \text{ OR } B) = P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$= P(4) + P(3) - P(4 \cap 3)$.

$P = (1, 2, 3, 4, 5, 6)$.

$= 7 - P($

$P(A) = \frac{1}{6} + \frac{1}{6}$.

$= \frac{2}{6} \cancel{- \frac{1}{6}}$

$P(A \cup B) = \frac{2}{6} =$

$P(A \cup B) = \frac{1}{3}$

Slv.

$P[3 \cup 4] =$

$P(3) = \frac{1}{6}$

$P(4) = \frac{1}{6}$

$P(3 \cap 4) = 0$

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$= \frac{1}{6} + \frac{1}{6} - 0$

$= \frac{\cancel{2}}{\cancel{6}}$

$P(A \cup B) = \frac{1}{3}$

Q No:

A Bag consist of 8 Red ~~ball~~ marbils, 7 blue marble, 6 green marbles. and 4 Yellow marbles.
What is the probability of Selecting.

(i) A red marble
(ii) A Blue marble first try and then a green marble on second try with replacment

(iii) the yellow marble on the first try & then a red marble on the second try ~~a red~~ without replac

(iv) two blue marbles with replacment
(v) two green marble without replacmt

Sol:

Color	Qty of marble
Red	8
Blue	7
Green	6
Yellow	4
	25 marble

(a) Probability of Red marble

$P(R) = \frac{8}{25} = \cancel{0.3077}\ 0.32 = 32\%$

32% chance of selecting a red marble on first try.

(b)

$P(B) = \frac{7}{25} = 0.28$

with replacement Green

$P(G) = \frac{6}{25} = 0.24$

$P(BG) = \frac{7}{25} \times \frac{6}{25} = 0.067 = 6.72\%$

$$\boxed{\begin{array}{l} (b) \\ P(BG) = \frac{7}{25} \times \frac{6}{25} \\ = 0.067 \\ P(BG) = 6.72\% \end{array}}$$

(c)

~~$P(Y) = \frac{4}{25} = 0.16$~~

~~without replacement Red.~~

~~$P(R) = \frac{8}{24} = 0.333$~~

$$\boxed{\begin{array}{l} (c) \\ P(YR) = \frac{4}{25} \times \frac{8}{24} = \\ = 0.16 \times 0.333 \\ = 0.053 \\ = 5.3\% \end{array}}$$

(d) two blue marble with replacement

= ;

$$\boxed{\begin{array}{l} \quad P(B) + P(B) - P(B \cap B). \\ P(A \cup B = 0.28 + 0.28 - (\cancel{B}). \end{array}}$$

$\frac{7}{25} \times \frac{7}{25}$

$P(BB) = 0.28 \times 0.28 = 0.078 = 7.84\%$

(e) Two Green marble without replacement

$$= \cancel{\frac{6}{25} \times \frac{6}{24}}$$

$$= \cancel{0.24 \times 0.25} = \cancel{0.06} = \cancel{6\%}$$

$$= \cancel{0.079}$$

$$= \frac{6}{25} \times \frac{5}{24}$$

0.24×0.203

$P(GG) = 0.05 = 5\%$

Last year mid term Question

Q No:

The Reliability of a missile is 0.85. If a salvo of two missile is fire.

what is the Probability of at least one hit

Note:

Assume independance of missile hits

Solve the Problem using

(a) Probability Equation for two independent event

(b) Sequential tree Diagram Construction

(c) Basic Probability technique

Hint:

Probability of A or B occuring if A & B are independent.

$$P(A+B) = P(A) + P(B) - P(A)P(B)$$

$P(\text{missile } 1) = P(m_1) = 0.85$

$P(\text{missile } 2) = P(m_2) = 0.85$

Solv (Teacher).

Let
A be the event for 1^{st} missile hit

B be event for 2^{nd} missile hit

So

$$P(A) = P(B) = 0.85$$

Failure. $P(\bar{A}) = P(B) = 0.85$

$$P(A+B) = P(A) + P(B) - P(A)\,P(B)$$

$$= (0.85) + (0.85) - P(0.85)(0.85)$$

$P(A+B) = 0.9775$ Ans

$P(A+B) = 98\%$

(b) $S.S = \{HH, HM, MH, MM\}$.

there are 4 possible outcomes.

$\{AB, A\bar{B}, \bar{A}B, \bar{A}\bar{B}\}$.

$$\boxed{\begin{aligned}&\text{for possibility of atleast 1 hit} \quad \times \\ &= \\ &= \frac{3}{4} = 0.75 = 75\%\end{aligned}}$$

Now lets take the probability of both missile.

$P(\bar{A}) \times P(\bar{B}) = P(\bar{A}\bar{B})$

$(0.15) \times (0.15)$.

$P(\bar{A}\cdot\bar{B}) = 0.0225 = 2.25\%$

Probability atleast one hit

$P(S) = 1 - P(F)$

$= 1 - 0.0225$

$P(S) = 0.9775$

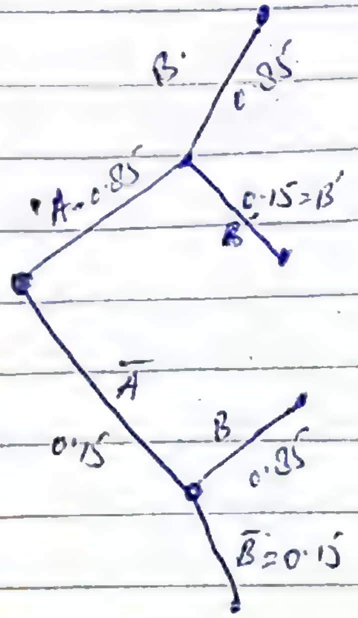
$P(S) = 97.75\%$

7. oil Process: Quality Reports
oil losses.

① Sequential Tree diagram

$\{AB, A\bar{B}, \bar{A}B, \bar{A}\bar{B}\}$ Rough work
0.7225 0.1275 0.1275 0.0225.

$= 0.7225 + 0.1275 + 0.1275$
$= 0.9775.$



$= 1 - 0.9775$
$= 0.0225$ miss

M.E = mutually exclusive

$P(AB) = 0.85 \times 0.85 = 0.7225$

$P(A\bar{B}) = 0.85 \times 0.15 = 0.1275$

$P(\bar{A}B) = 0.15 \times 0.85 = 0.1275$

$P(\bar{A}\bar{B}) = 0.15 \times 0.15 = 0.0225$

Probability of hit divided by Summing the Product of each path which leads to at least on hit As each path are (M.E)

$P(AB) + P(A\bar{B}) + P(\bar{A}B)$

$= 0.7225 + 0.1275 + 0.1275$

$\boxed{P(\text{System}) = 0.9775}$

Note:

$P_1 + P_2 + P_3 + P_4 + \cdots\cdots P_n = 1$

For

Q No

Sarah is ~~deciding~~ which course She wants to take in her next college Semester: Probability that She enrolls in an Algebra course is 0.3 and Probability that She enrolls in a biology Course is 0.7. Probability that Shee will enroll in Algebra ~~biology~~ course given that She will enrolls in biology course is 0.4

(a) What is the Probability that Shee will enroll in both an Algebra & Bilogy course

(b) What is the Probability that Shee will enroll in an algebra course or a biology course

(c) Are the two events independent (Proof that).

(d) Are the two events mutually exclusive

$$\cancel{P(A \,\&\, B) = P(B/A) \times P(A)}$$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B).$$

(a)

$P(A)$ = Algebra = 0.3.

$P(B)$ = biology = 0.7

$P(A \cap B)$ = 0.4

$P(A) = \frac{0.3}{1} = 0.3$ Rough work

$P(A \,\&\, B) = (0.4)(0.3)$.

$= 0.12$

Sol (Teacher).

$P(A) = 0.3$

$P(B) = 0.7$

$P(A/B) = 0.4$

(a)

$P(A \,\&\, B) = P(A/B) \times P_B$

$= 0.4 \times 0.7$

$P(A \,\&\, B) = 0.28 = 28\%$

(b) $P(A \cup B) = P(A) + P(B) - P(A \cap B)$.

$= 0.3 + 0.7 - 0.28$

$=$

$P(A \text{ or } B) = 0.72 = 72\%$

(c) Are that two events independent

$P(A/B) = P(A)$.

$0.4 = 0.3$

$0.4 \neq 0.3$

Events are not ~~dependent~~ independent

(d) Are the two events mutually Exclusive we use

$P(A \text{ and } B) = 0$

But we know that

$P(A \text{ and } B) \neq 0$

$P(A \& B) = 0.28$

Event (A & B) are not mutually.
Exclusive event.

Failure

Deterministic failure

Random failure

Random failure:

They may exhibit a pattern that can be modelled by some probability distribution

Random variable :-

They allow us to pass from experimental outcome to a numerical function of the outcome.

Types of random variable
(Count those unknown).

1. descreate random variable
2. Continuous random variable
(Temp, man,
as heat)

Standard deviation
Sample position $\bar{x}$

L # C.

FMEA

Failure mode & effective analysis.

- Design failure mode & Effective analysis. (DFMEA)
- Process failure mode & effective analysis. (PFMEA)

mid Term Paper / Pattern

// MTTF vs MTBF

Q:

- $R(t) = 1 -$ failure

~~Name the~~ Difference b/w following

- Quality vs Reliability
  MTTF v/s MTBF
- Name potential ways to improve reliability.

- why product fail.

Q

20 unit are put on test

MTTF,
calculate the failure rate

Q bath tub curve Sketch
Explain the three main failure rate feature

$$f(t) = \begin{cases} 0.002e^{-0.002t} & t \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

ⓐ $R(t) =$
ⓑ MTTF
ⓒ median

Paper Pattern

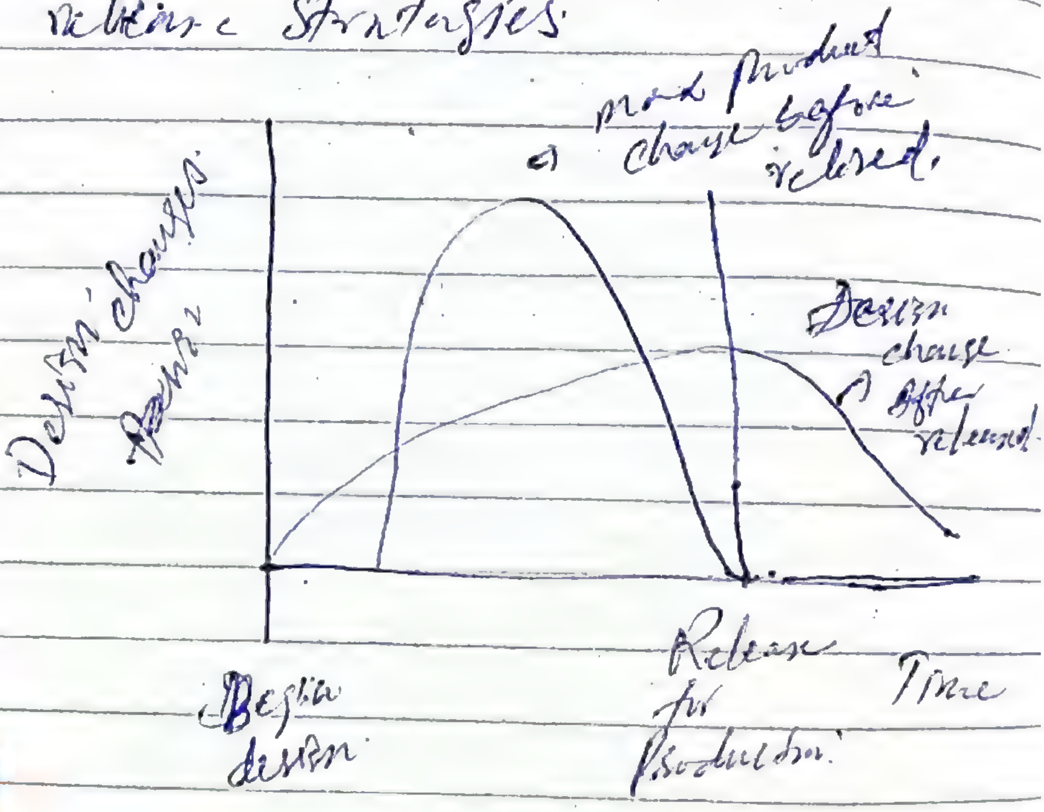
Proof mathematical MTTF.

$$MTTF = \int_0^{\infty} R(t)\, dt$$

RAP.

Details

D. release Strategies



Mid life upgradation (MLU).

: FMEA :-

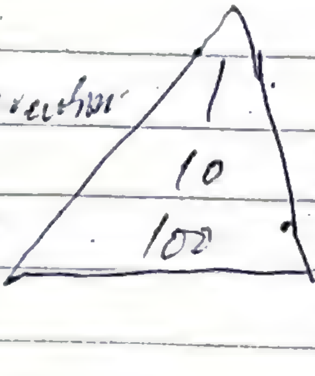
- Technique Risk Assessment prior to release of design, process or service

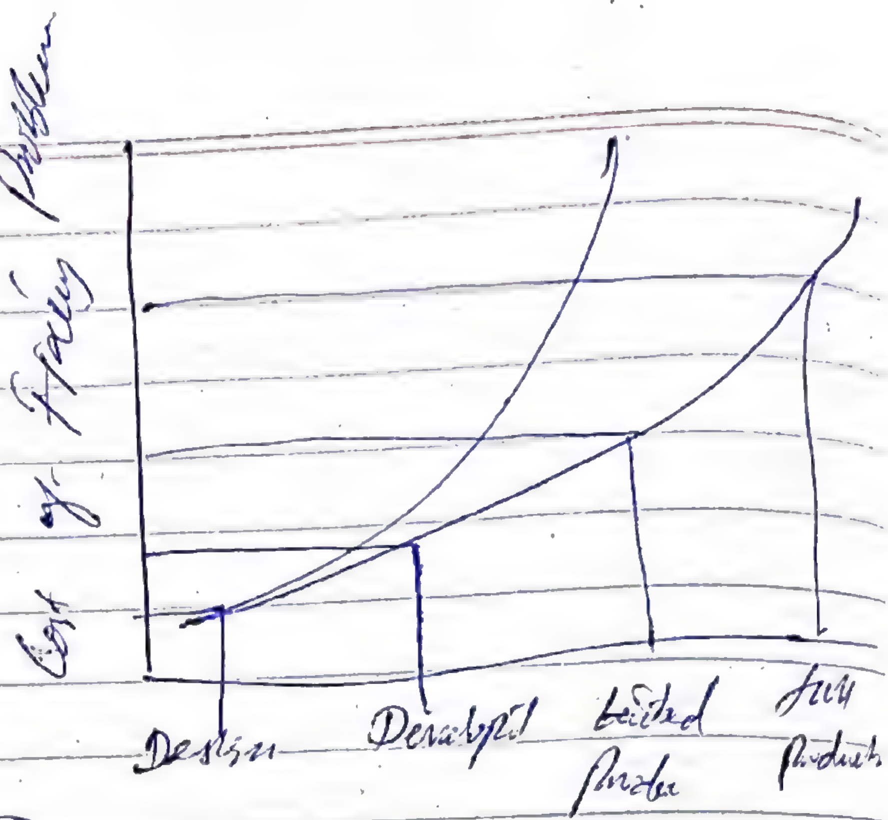
Severity
occurance
probability of detection in the event of occurrence

RPN → Number → S × O × D.
10 × 10 × 10

Risk Priority

The
1 - 10 - 100 Rule
one dollar spent on prevention
10 dollar on correction.
100 dollar on failure cost





Stage (1)
(1) cost of design fixation is less.
Cost of Development is more cost as compare to design. Stage (2)

Stage (3)
Limited production cost is high at this stage and failure at this stage the fixation cost of very high b/c they design the production machines for this product.

Stage (4)
full production the fixture al machine design.
Dies, fixture how produced machines are design automation assembly has design.

CQI = continuous Quality. | (1) High viscosity
Ball rotation

Benefits of PMEA.

(1) Higher reliability
(2) Better quality
(3) increased Safety,
(4) Enhanced customer ~~satis~~ satisfaction ~~contribution~~
(5) Contributes to cost saving
(6) Decrease development

DPMEA : Roadmap. (Note
Quality Function Development:

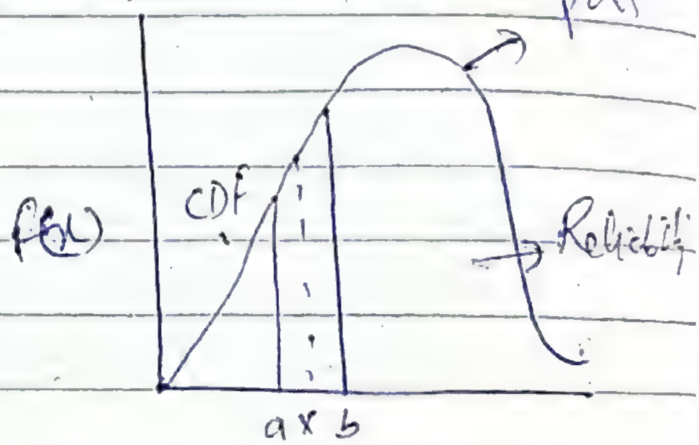
L C #

- Random variable

Redundancy → backup → Standby.

- Discreat
- ~~ete~~ Continuous

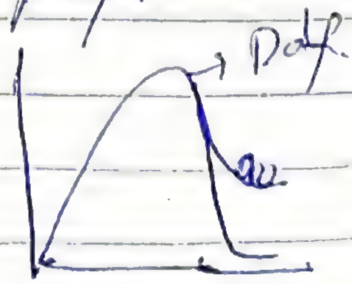
① Probability Density function (PDF)



② Cumulative Function.
③ Reliability function. R(t)

Probability Density Function (Pdf).

For f(x) to be a pdf.



Importance Reliability

$5000 + \infty = \infty$
$\infty \cdot 5000 = \infty$
$\frac{1}{\infty} = 0$

Example (pdf)

$$f(x) = \begin{cases} c(4x - 2x^2) & 0 < x < 2 ? \\ 0 & \text{otherwise} \end{cases}$$

$$f(x) = \int_0^2 4x - 2x^2$$

~~$f(x) = 4 + 4x$~~
~~Apply the limits.~~
~~$f(x) = 0$~~
~~$f($~~

$$\int_{-\infty}^{\infty} f(x)\,dx = \int_{-\infty}^{0} f(x)\,dx + \int_{0}^{2} f(x)\,dx + \int_{2}^{\infty} f(x)\,dx = 1$$

Sol

$$= \int_0^2 c(4x - 2x^2)\,dx = 1$$

Example:

Time to failure (in hr) for a capacitor has the following pdf what is the probability of failure by t = 200 hr?

$$f(t) = 0.01\,e^{0.001t}$$

Since its true it must

$$f(x) = \int_{-\infty}^{x} f(x)\,dx$$

$$= \int_{0}^{200} \cancel{0.01\,e^{0.001t}}\, f(t)\,dt$$

$$P(t \le 200) = \int_{0}^{200} 0.01\,e^{-0.001t}\,dt$$

Formula.

$$F(x) = \int_{-\infty}^{x} f(y)\,dy$$

$$R(x) = \int_{x}^{\infty} f(y)\,dx$$

$$f(x) = \frac{dF(x)}{dx}$$

$$F(x) = 1 - R(x).$$

$$\therefore \frac{dF(x)}{dx} = \frac{d\,R(x)}{d(x)} = f(x),$$

Why Improve Reliability
potential ways to Improve Reliability

Failure rate or Hazard.

$$\lambda = \frac{f(t)}{R(t)}$$ Reliability function

Prove:

$$1 - R(t) = \frac{dF(t)}{dt}$$

$$\lambda(t) = \frac{f(t)}{Rt}$$

$$\frac{\frac{dF(t)}{dt}}{R(t)} = \frac{\frac{d[1-R(t)]}{dt}}{R(t)} = \frac{\frac{-dR(t)}{dt}}{R(t)}$$

$$\lambda(t)\, dt = \frac{dR(t)}{R(t)}$$

$$\int_0^t \lambda(t)\, dt = \int_1^{R(t)} \frac{dR(t)}{R(t)} = -\ln R(t)$$

$$R(t) = e^{-\int_0^t \lambda(t)\, dt}$$

Impord
1.***

$I(t) = \lambda(t)$ Reliability
Meth.

(22/11/24.)

Problem:-

Given the Hazard function when t is measured in operating A hours. what is the design life if a 0.98 reliability is desired. Take Hazard function.

$$\lambda(t) = 5 \times 10^{-6} (t).$$

Sol:-

$$R(t) = e^{-\int_0^t \lambda(t)\, dt}$$

$$= e^{-\int_0^t 5\times10^{-6}\, t\, dt}$$

$$R(t) = e^{-\left[\frac{5\times10^{-6}\times t^2}{2}\right]_0^t}$$

$$0.98 = e^{-[2.5\times10^{-6} t^2]}$$

$$\ln 0.98 = \ln e^{-[2.5\times10^{-6} t^2]}$$

$$\ln 0.98 = 2.5\times10^{-6} t^2 \times 1$$

$$t^2 = \frac{0.0202}{-2.5\times10^{-6}}$$

$$\boxed{t = 89.88 \text{ hrs}}$$

$f(x) = (pdf)$

$F(x) = CDF$

$f(x) = pdf$

Problem:

Given that $\overset{pdf}{f(x)} = 0.048x[5-x]$

(a) Varify that f is a pdf

(b) What is the probability that "x" is greater than 4.

(c) what is the probability that x is in b/w 1 & 3 ~~inclusive~~ inclusive.

Sol.

$$\int_{-\infty}^{+\infty} f(x)\,dx = 1 \rightarrow \boxed{\text{Formula}}$$

$\downarrow$

integral from $-\infty$ to $+\infty$ for any $pdf = 1$

Sol.

$$\int_{-\infty}^{+\infty} f(x)\,dx = 1$$

(a)

$$f(x) = 0.048x(5-x)$$

for

$$\int_{-\infty}^{+\infty} 0.048x(5-x)$$

(a) If

$$f(x) = 0$$

$$0.048(0)[5-0]$$

$$f(x) = 0$$

(b)

If $f(x) = 5$

$$= 0.048(5)[5-5]$$

$$f(x) = 0$$

So x must be b/w $0 \leq x \leq 5$

It will give the result so if we integrate from

$$\int_0^5 f(x)\,dx = 1$$

$$= \int_0^5 0.045(x)(5-x)\,dx$$

$=$ So $f(x)$ is a Pdf.

(b) $$P(4 \le x < 5) = \int_4^5 0.048x(5-x)\,dx$$

$P(4 \le x \le 5 = 0.104 = 10.4\%$

(c)

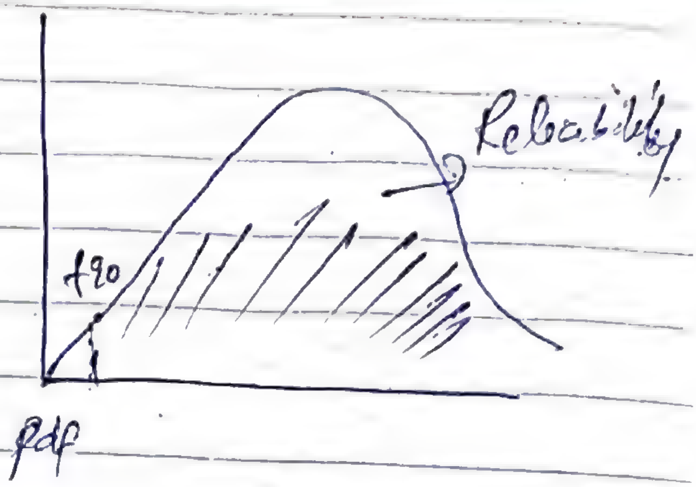
$$P(1 \le x\,3) = \int_1^3 0.048x(5-x)\,dx.$$

54.4%

Date:

Design Life

a



Very Important design life $d(t)$ calculate

~~Probabili~~

Problem...:

Given the following pdf. for the random variable T the time in operating hr) to failure of a compressor. what is its reliability for a 100 hr. operating life? what is the design life for 95% reliability.

Solution

$$f(t) = \begin{cases} \dfrac{0.001}{(0.001t+1)^2} & t \geq 0 \\ 0 & \end{cases}$$

$$f(t) = \frac{0.001}{(0.001t+1)^2} \qquad t \geq 0$$

$$R(t) = \int_t^{\infty} \frac{0.001}{(0.001t+1)} \, dt$$

let

$$U = [0.001t + 1]$$

$$\frac{dU}{dt} = 0.001$$

$$\frac{du}{0.001} = dt$$

$$= \frac{0.001}{0.001}\int_t^{\alpha} \frac{du}{U^2}$$

$$= \int_t^{\alpha} \frac{dU}{(U)^2}$$

$$= \int_t^{\alpha} U^{-2}\, dU$$

$$= \left[\frac{U^{-2+1}}{-2+1}\right]_t^{\alpha}$$

$$= -\left[\frac{1}{U}\right]_t^{\alpha}$$

$$\left[-\frac{1}{\alpha} + \frac{1}{U}\right]$$

$$0 + \frac{1}{U}$$

$$0.1 \quad \frac{1}{U}$$

$$R(t) = \frac{1}{(0.001t + 1)}$$

$$\cancel{0.95\% = \frac{1}{(0.001t + 1)}}$$

$$(0.001t + 1)\ 0.95 = 1$$

$$R(100) = \frac{1}{[0.001 \times 100 + 1]}$$

$$\boxed{R(100) = 0.909}$$

(b) Design life for 95% Reliability

$$0.95 = \frac{1}{0.001t + 1}$$

$$0.95 \times (0.001t + 1) = 1$$

$$0.00095t + 0.95 = 1$$

$$0.00095t = 1 - 0.95$$

$$t = \frac{0.05}{0.00095}$$

$$\boxed{t = 5.55}$$

$$\boxed{t = 52.631 \text{ hrs.}}$$

Median

Exact median of an function = 50th percentage.

Problem:

Consider the following pdf with X in hrs.

$$f(x) = \begin{cases} 3/8\,(4x - 2x^2), & 0 < x < 2 \\ 0 & \text{otherwise} \end{cases}$$

~~median~~ find mode

$$F(x) = R(x) = 0.5$$

$$F(x) = \int_0^x \frac{3}{4}(4t - 2t^2)\,dt = 0.5$$

$F(x) = \frac{3}{8}\left(2x^2 - \frac{2}{3}x^3\right) = 0.5$

$F(t_{50}) = \frac{1}{2}$

$f(x) = R(x) = 0.5$

$= \int_0^x \frac{3}{8}\left[4t - 2t^2\right] dt = \frac{1}{2}$

$\frac{3}{8}\left[2t^2 - \frac{2}{3}t^3\right]_0^x = \frac{1}{2}$

$2x^2 - \frac{2}{x}x^3 = \frac{8}{6}$

$-\frac{2}{3}x^3 + 2x^2 = \frac{4}{3}$

$= 2.736$ × $0 < x < 2$

$= 0.99505$

$= -0.731$ ×

0 ..